SOIL CONSERVATION

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Livestock Industry Benefits From Range Management Program

By A. T. Semple[1]

From the beginning of our work on public land projects in 1934, we have kept records showing changes in range land use for the improvement of perennial grass stands and to increase the cover needed on the land to reduce soil and water losses. On July 1, 1937 an additional set of records was instituted to collect data on soil conservation operations as affecting livestock numbers and their dependence upon pasturage. This recording system included operations on all private and public land projects of the Soil Conservation Service. Thus far, the data indicate a reduction in the number of livestock on range land in the western part of the United States. While as yet actual data showing the production of these reduced numbers are not available, there is ample information from field observations to indicate that cattle and sheep ranges stocked at carrying capacity produce more abundantly and more profitably than overstocked ranges.

AT THE end of March 1938, nearly 11 million acres on 59,216 farms had been brought under agreement on private land projects since the beginning of the work in 1934. The cooperative agreements provided for an 8.8-percent increase of the pasture acreage on these farms. On the 8,768 farms for which agreements were signed between July 1, 1937, and March 31, 1938, the pasture acreage was increased 21 percent. This indicates very creditable progress in our soil conservation program. Records on 310,578 acres of pasture brought under agreement during the above 9 months' period show that fully two-thirds of the acreage was overstocked. Accordingly, it is important that by means of pasture improvement the number of animal units provided for by the agreements is 10 percent greater than the number formerly kept on the farms. It is remarkable that the average period of grazing was increased from less than 6 months to more than 6 months. Undoubtedly, it is expected that pasture treatments such as fertilizing and contour furrowing will add to productivity. During the 9 months' period, about 12 percent of the pasture acreage put under agreement was treated with contour furrows, ridges, and terraces. Over half was contour furrowed.

The 10 percent increase in the number of animal units provided for by plans for conservation operations on farms does not indicate necessarily an increase in the production of livestock and livestock products. In many cases, it means a better distribution of livestock which makes it possible for farm families to have such products as fresh milk and meat. Many of these families heretofore were without livestock or the means to such products.

On March 31, 1938, more than 20 million acres of range land were under agreement on private and public land projects, chiefly in the 11 western range States. For the past 9 months, on private range land brought under agreement, livestock was reduced 10 percent, while on public land projects the decrease was 27 percent.

(*Continued on p. 71*)

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Range Conservation on Big Horn Draw

By Thomas E. Doughty [1]
and Kenneth Fiero [2]

This rank stand of western wheatgrass, along one of the water-spreading structures in the Big Horn area, is typical of several hundred areas of this grass and blue grama, which resulted from approximately 50 stock-water and water-spreading dams constructed in the main and lateral drainages. Protection for natural reseeding was provided by controlled grazing.

THE results of range conservation on Big Horn Draw are typical of those to be expected over wide areas in the range country. Big Horn Draw is a segment of the Shoshone Indian Reservation on which a cooperative soil conservation project is being developed by the Soil Conservation Service and the Indian Service.

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This range comprises a dry prong on the Little Wind River, 21 miles north of Lander, Wyo. The drainage is 15 miles long, drops 1,200 feet from source to mouth, has a wide alluvial valley flanked by steep, rocky slopes, and covers about 35,000 acres of typical Rocky Mountain foothill range land.

The area is an ancestral grazing ground of local Indians and has been used for years as a livestock trail between winter and summer range. In addition,

livestock owned by Indians and whites alike have had access to it on a year-long basis; consequently, the native vegetation became so closely shorn that it resembled scarcely at all its former climax condition. Grama, spiked wheat and slender wheatgrasses, needlegrass, nigger-wool, and sagebrush now are the main forage plants found on the slopes. On bottom lands, salt sage, brown sage, western wheatgrass, and small amounts of greasewood are the dominant plant species.

In 1935, one water hole at the junction of the Big Horn Draw and the Little Wind River, on the extreme southern portion of the range, provided the only permanent water available. Besides the permitted stock and the trail herds that loitered unnecessarily, a herd of 350 nondescript ponies were using the area. As a consequence of this indiscriminate grazing, a network of stock trails, cut deeper each year by hard trampling feet and running water, slashed the whole terrain adjacent to the water gap.

All types of erosion—wind, gully, and sheet—were present in a serious degree of advancement. Wind erosion was especially prevalent through the center where the soils vary from a clay to sandy texture. These soils had blown badly, with a removal in places of 12 inches and a resulting accumulation in hummocks often 20 inches high. Gullies, many of them 6 feet in depth, were especially prevalent in the draws of steep gradient with courses meandering down from the steep slopes on the north, east, and west sides into the center of the area. Deep steep-sided gullies, as much as 15 feet in depth, had also developed down the center of the draw from torrential rains. Sheet erosion was everywhere evident on all slopes regardless of soil texture, as there was little vegetation to decrease the erosive velocity of the waters. The main drainage extends up the area for about 9 or 10 miles where it branches into three smaller head drainways.

This range lies within a torrential rain belt where cloudbursts are recurrent during the summer months. Naturally, the denuded range lands offered an admirable medium for run-off and, according to engineers' estimates, 5,000 second-feet of water often escaped the draw during one downpour. This high intensity of rain, falling on the denuded gumbo soils ran off rapidly, collected into torrents, and rumbled down Big Horn Draw laden with silt, into the Little Wind River, a clear mountain stream.

In the fall of 1935, a joint soil conservation program was initiated between the Soil Conservation Service and the Indian Service for the correction of the malpractices destroying the range. The Soil Conservation Service made range and conservation surveys. A drift fence was constructed, thereby shifting the stock trail out of the denuded draw, and the Indian Service removed the surplus livestock from the area, allowing only permitted livestock to graze.

The conservation, engineering, and range surveys indicated that Nature would have to have assistance for rapid revegetation and to halt erosion. The main gullies were plugged with small dams and diversion ditches, made by a blade, which carried the water from the gullies on to the gentle alluvial bottoms where other spreading ditches kept the water deployed over the land and out of low places as far as possible.

Large stock-water dams were constructed approximately 3 miles apart to establish more or less permanent water. Insofar as possible, the stock-water dams were located adjacent to fertile alluvial valleys where spillway water is carried out and spread to increase native forage production.

The spreading system was laid out to simulate an automatic system of irrigation. A ditch, made by the grader pulled by a tractor, was run off on a slight gradient and finally leveled on a zero grade. The ditch was broken for several feet on the high places to assure effective spreading. When the water began to concentrate below, additional ditches were made to carry it away from depressions. The spreader ditches used on this range have an estimated water-holding capacity of 1 acre-foot for 43,560 linear feet of ditch. The purpose of the ditches is to hold part of the run-off and slow down and distribute the remainder of the water over a wide surface for maximum absorption.

In addition to the structural developments on this range, proper grazing management practices were likewise advocated. Trespass stock are kept from the area; sheep graze it during the winter, bed grounds being moved at least once every five nights while the old established bed grounds are avoided. A salting plan has been provided for both cattle and sheep. The salt is placed away from water holes and scattered out on strategic points. This is an aid to the proper distribution of cattle and horses.

The cooperative program of soil conservation has brought about a marked improvement on the range area in Big Horn Draw. While precipitation in 1937 was above average, the mechanical structures applied on the area held the complete rainfall so that none escaped into Little Wind River.

In 2 years, the native vegetation has made a remarkable recovery. The following information offers some typical results of the soil conservation practices:

Looking south on Big Horn Draw. In the foreground, a large stock-watering dam and a water-spreading system; in background, typical range land.

After one season of water-spreading, blue grama was clipped, on October 15, 1936, from plots 100 square feet in area, and its yield was compared to similar clippings of blue grama on untreated areas, neither subjected to grazing. Two and eight-tenths (2.8) as much blue grama was produced on the treated area as on the untreated area. This is significant in that the grama composed 96 percent and 89 percent of the total vegetation present respectively.

The following spring (June 21, 1937) similar clippings were made to determine the effect of increased plant vigor, resulting from the water-spreading of the previous year, on the abundance of early spring growth. The amount of forage produced immediately below the water-spreading structures was two and one-tenth (2.1) times as great as it was above. The differences on the treated area are probably due to the impounding effect of the spreader ditch which allowed the vegetation below the structure to receive both surface and underground water.

The percentage of moisture above and below the spreader structure in the first 2 inches of soil was found to be 6.78 percent and 10.85 percent, respectively. In the 2- to 6-inch depth it was approximately the same, being 19.56 percent and 19.86 percent, respectively. In the 12- to 16-inch depth the percent of moisture was 7.09 percent and 9.15 percent, repectively, or 23 percent higher below the spreader ditch. These figures seem to bear out the statement above, accounting for the increased yield below the spreader ditch.

The cost of constructing these spreader ditches, with a 22-horsepower gas caterpillar tractor and terracer, was $15.20 per mile; with a 60 hp. Diesel caterpillar tractor and blade, the cost was $3.91 per mile.

More About Crop Rotation

Recent observations at Garland, in the Black Belt of Texas, brought out several interesting points regarding the possible effect of crop rotation on cotton root rot. Cotton grown in strips which had been in small grain for one year showed much less infestation by cotton root rot than that grown in adjoining strips which had been continuously in cotton. It is known that the grass family, which includes small grains, is immune to cotton root rot.

Little bluestem has been successfully established at Garland by planting the seed with an ordinary cotton planter set wide open. Seedings made last spring were producing seed in the fall. Ryegrass is making a wonderful showing at Garland and some farmers have had excellent returns from seed production.

These facts show the opportunities offered by diversification in farming practices in the Black Belt. Not only has infestation by cotton root rot been diminished, but sources of income other than cotton production have been initiated and, by contour strip cropping and the use of close growing vegetation in rotation, erosion control has been effected.—*C. R. Enlow.*

Corrugation Furrows in the Smoky Hill River Project

DROUGHT, overgrazing and wind and water erosion have severely depleted native grass pastures in the vicinity of the Smoky Hill River project of the Soil Conservation Service, located at Cheyenne Wells, Colo.

Buffalo, grama and other native grasses, which according to the old-time residents once covered the range with a solid protective sod, have been destroyed to a point where much of the ground is bare and subject to intense wind and water erosion. A wide variety of weeds and annual grasses of little erosion resistance or value as livestock forage has replaced the native grass cover in many places.

Dust storms of recent years have covered these native grass pastures with a fine colloidal silt deposit of varying depths which is almost impervious to moisture penetration. This condition, combined with the sparse vegetative cover, has greatly accelerated the run-off from the subnormal rains of recent years. As a result, only a small amount of moisture has been taken into the soil where it could be utilized by the grass roots. Rainfall run-off tests on average slopes and soils at Cheyenne Wells show an average of approximately 70 percent from a 2-inch rain.

Approximately 40,000 acres of pasture land in the Smoky Hill River project area have been contour furrowed during the last 2½ years. Water conservation structures of a wide variety have been built, depending upon the soil types, slopes, equipment, and labor available. Farmers and ranchers have observed that any type of contour furrow or ridge that will prevent run-off is of great value in the control of water erosion and the stimulation of vegetative growth.

Technicians of the Cheyenne Wells project have developed a unique type of contour furrow which for want of a more appropriate name is being called "corrugation." This type of furrowing has been done on approximately 10,000 acres of grassland in the area during the last year. Visitors from adjoining counties and States have viewed this work, and now similar furrows are being constructed in many different localities.

Corrugation furrows at Cheyenne Wells are being constructed with an 8-foot road grader or terracer. The cutting blade of the machine is removed and three shovels, each 5 inches wide and 5 inches deep,

Terracing-machine blade, as equipped for corrugation work on the Smoky Hill River project. Shovels are fastened to the blade, and extensions to the blade are provided for a better spreading of the disturbed soil.

By W. R. Watson[1]

are bolted to the blade proper, one shovel at each end of the blade and one in the center. Three furrows, each 5 inches wide and 5 inches deep, are made at one time. Extensions made of boiler plate, 2 feet in length, are fastened to each end of the blade beyond the outside shovels. The furrowing machine is pulled by an ordinary farm tractor.

In operation, the blade is set so that it clears the surface of the ground by about an inch. Dirt thrown out by the shovels is distributed evenly between the furrows by the blade and extensions. Only 15 inches out of a possible 96 inches of sod are disturbed and none of the sod is covered to the extent that the grass cannot come through.

Persons who have observed this type of furrowing believe that the mulching of the spaces between the furrows by the topsoil from the furrows is beneficial to vegetative growth.

The furrows can be made with numerous adaptations of the terracer or grader. A lister with the moldboards clipped and a drag attached will construct a similar furrow. Most any farmyard will provide sufficient material to build a furrowing machine of this type.

[1] Associate range examiner, Agronomy and range management section, Soil Conservation Service, Amarillo, Tex.

New "corrugated" furrows on which no rain had fallen. Note how soil from furrows spreads evenly over area, not too deep for the grass to come through.

Furrows of this type are not being constructed on sandy or highly dispersible shale soils as it is felt that they would be too short-lived to be effective. Such furrows on heavier soils have shown little silting at the end of the first season—except where uncontrolled run-off from adjoining pastures or blow dirt from adjacent cultivated fields were hazards.

These furrows, constructed in August 1937, had received about an inch of rain. There is no trace of the upturned soil. The Buffalo and gramas are making a nice showing.

On slopes of 2 percent or less, corrugation furrows usually are constructed on half of the land in alternate strips. On steeper slopes, the pastures are furrowed solid at 4-foot intervals. Where the slopes are steep and the topography rolling with definite drainageways already formed, the furrows are used in conjunction with diversion structures. These structures take the excess water from the drainageway and divert it to adjacent pasture where it is spread evenly by the corrugations.

The value of corrugation furrows may best be illustrated by specific figures. Assuming that the furrows were spaced 4 feet apart and were of some nonporous material, it is found that one acre of land so treated would have a storage capacity in the furrows of 44,119 gallons of water. This storage capacity would be equal to the precipitation from a 0.51-inch rain without figuring any penetration between the furrows or allowing for any run-off.

A 2.25-inch rainfall early in the summer of 1937, just after the furrows were constructed, showed no appreciable run-off. This proved that the furrowing not only had stored a considerable amount of water, but also had improved the condition of the soil for absorbing moisture.

In order actually to compare vegetative results from this type of furrow with unfurrowed land, several tests have been conducted by technicians of the Smoky Hill River project at Cheyenne Wells.

A series of 10 plots, each one meter square, was laid out at 10-foot intervals in a pasture that had been furrowed at intervals of 4 feet. A similar group of 10 plots was laid out on an untreated pasture less than a hundred yards away. Soil types and slopes are the same. Vegetative density on both groups of plots was the same when the furrowing was done in April 1937.

At the end of the 1937 growing season when all vegetation was thoroughly cured, grass and weeds on all the plots were carefully clipped and weighed. The 10 plots on the furrowed area produced an average of 47.85 grams of air-dry grasses to the square meter. Plots on the untreated area produced an average of only 23.93 grams to the meter. Converted into pounds, the furrowed pasture produced 425.9 pounds of air-dry grass to the acre while the untreated pasture produced only 212.9 pounds. This air-dry grass was valued at $6 a ton. Based upon this valuation, production on the furrowed land was $1.27 an acre as compared with only 63 cents on the untreated pasture.

Cost of constructing corrugation furrows is 46 cents an acre for solid furrowing, and 26 cents an acre for treating half of the pasture in alternate strips. These costs include all charges for surveying, labor and equipment.

Grass growth on a pasture in the Cheyenne Wells project "corrugated" in April 1938. By actual weight tests, this pasture produced 435.9 pounds of air-dry grass per acre, as compared with a production of but 212.9 on nearby untreated land.

Technicians of the Soil Conservation Service point out that this type of furrow can be made by most farmers or ranchers without any investment in extra equipment, and that it is a job which can be done during the slack season.

Grazing Program in the Dry Land Section of Eastern Oregon

By E. William Anderson [1]

THE 2,860-acre ranch of an early pioneer near Heppner, Oreg., is typical of the medium-sized livestock ranch in the eastern Oregon dry land section in which the Soil Conservation Service is instigating range-conservation plans.

Area under-utilized, due to lack of water. "A" condition range with perennial bunchgrasses predominating.

The ranch is used for spring, summer, and fall grazing for about 160 beef cattle and 15 horses. During the late fall and early spring the livestock are grazed on an allotment in the No. 7 Oregon grazing district, and during the winter months on another ranch owned by the cooperator. All but 208 acres (cultivated) of the ranch is native bunchgrass range with bluebunch wheatgrass (*Agropyron spicatum*), Sandberg bluegrass (*Poa secunda*), and bluebunch fescue (*Festuca idahoensis*), constituting the major part of the vegetal cover.

A forage inventory was made of this ranch, with the square foot density method, to determine the range condition and serve as a basis for recommendations. A grazing plan was drawn up for the entire ranch. The plan consisted of the recommended dates of use for each unit, carrying capacity, and the class of stock to graze the area.

From an analysis of the range survey data the following conditions were found to exist: The range as a whole is in good condition. The A and B conditions (see accompanying map) show no sheet erosion to slight sheet erosion. The C and D conditions show moderate to severe sheet erosion with small gullies forming on the steeper slopes. The main drainages are all marked by gullies, some of which are partly stabilized by vegetation and others active to a severe degree.

The results of the range survey show that the past rate of stocking has not been in excess of the estimated carrying capacity. Due to lack of proper distribution of water over the ranch, however, some areas have received forced overgrazing while other areas remained under-utilized. The overgrazing has occurred in the immediate vicinities of several waterholes or on areas accessible from the waterholes. The result has been an increase of annual grasses and weeds with a decided reduction of carrying capacity and erosion-resisting cover.

With the major problem one of correct stock management, range conservation practices were incorporated into the ranch plan to obtain the desired stock distribution and to correct over-utilization of some areas. This may be noted on the map.

Four springs, evenly distributed over the ranch were developed to provide at least one spring to each section of land (640 acres). In this development the

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Overgrazed area in vicinity of the waterhole. "D" condition range, with annual grasses and weeds predominating.

springs were dug out and concrete cut-off walls and catchment basins were installed. Troughs were constructed from logs, and water was piped from the spring to the troughs. One to several troughs were placed at each spring so that water is now available throughout the dry summer and fall season. With the development of these springs, it is possible to graze the entire ranch under a system of deferred and rotation grazing by the proper number of stock and during the proper seasons.

To obtain more even distribution of grazing within the unit, salt ground sites were selected and coordinated with the spring developments in each grazing unit. These sites are all located on the ridge-tops away from the springs and will help in eliminating a concentration of grazing around the springs and in the adjacent canyon bottom. Sufficient sites were selected in each grazing unit so that the aggregate grazing between and around the spring and salt grounds would thoroughly cover the unit.

Salt is provided at the rate of 2 pounds per head per month, and the number of pounds to be put in each grazing unit is computed by the number of animal months of use which the unit will receive, as outlined in the grazing plan.

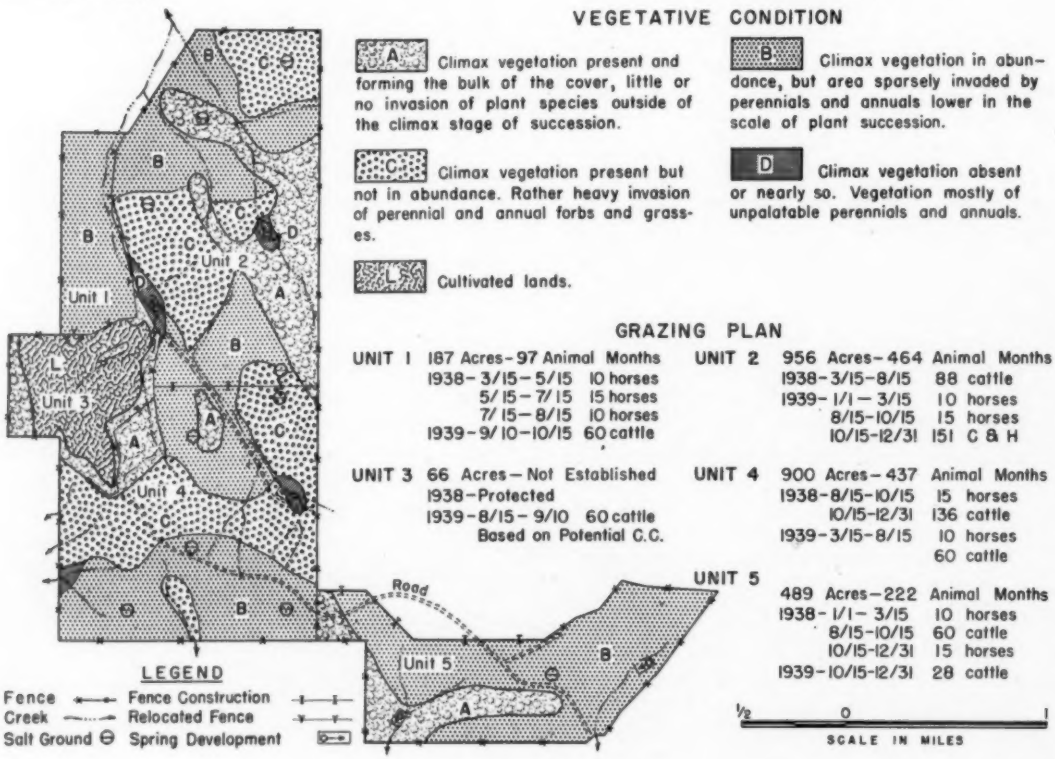
The system of rotating the use of the salt grounds is such that the salt will be changed from one salt ground to another as soon as the range in the immediate vicinity is utilized to the desired intensity. By this method of rotation it is possible to give added protection to the overgrazed areas of each unit.

In this dry land area where native range is used for spring and summer grazing, it is very important that no grazing be allowed until the range growth is 6 to 8 inches high. It is also very important that the perennial grasses be allowed to mature seed for natural revegetation at least once every 4 years.

In order to make possible the deferred system of grazing, and to simplify the management of the stock for more even grazing distribution, it was necessary to divide a large area into two separate grazing units by construction of a three-wire cross fence; thus three major range units were formed for the deferred and rotation system of grazing. The location of this fence was selected so that the carrying capacities of the resulting two units would be quite similar, simplifying management of the stock by having equal periods of use.

In one place it was necessary to construct approxi-

(*Continued on p. 83*)


VEGETATIVE CONDITION
A Climax vegetation present and forming the bulk of the cover, little or no invasion of plant species outside of the climax stage of succession.
B Climax vegetation in abundance, but area sparsely invaded by perennials and annuals lower in the scale of plant succession.
C Climax vegetation present but not in abundance. Rather heavy invasion of perennial and annual forbs and grasses.
D Climax vegetation absent or nearly so. Vegetation mostly of unpalatable perennials and annuals.
L Cultivated lands.
GRAZING PLAN
UNIT 1 187 Acres–97 Animal Months
1938–3/15–5/15 10 horses
5/15–7/15 15 horses
7/15–8/15 10 horses
1939–9/10–10/15 60 cattle
UNIT 2 956 Acres–464 Animal Months
1938–3/15–8/15 88 cattle
1939–1/1–3/15 10 horses
8/15–10/15 15 horses
10/15–12/31 151 C & H
UNIT 3 66 Acres–Not Established
1938–Protected
1939–8/15–9/10 60 cattle
Based on Potential C.C.
UNIT 4 900 Acres–437 Animal Months
1938–8/15–10/15 15 horses
10/15–12/31 136 cattle
1939–3/15–8/15 10 horses
60 cattle
UNIT 5 489 Acres–222 Animal Months
1938–1/1–3/15 10 horses
8/15–10/15 60 cattle
10/15–12/31 15 horses
1939–10/15–12/31 28 cattle
Unit 1
Unit 2
Unit 3
Unit 4
Unit 5
Road
LEGEND
Fence
Fence Construction
Creek
Relocated Fence
Salt Ground
Spring Development
½ 0 1
SCALE IN MILES

SOIL CONSERVATION PRACTICES ON RANGE AND PASTURE LANDS SHOW INCREASED RANCH INCOME

BY AVERIL B. NIELSON [1]

RANGE conservation measures which have been applied in project and camp areas in eastern Washington and northeastern Oregon are now showing increased profits to livestock operators. The 1,322-acre livestock-wheat ranch of a pioneer settler at Pomeroy in Garfield County, Wash., is here described as an example of typical results obtained through the establishment of a sound, long-time agricultural program.

The land over much of this territory was originally used for grazing livestock. Settlers arrived in the early seventies, the bunchgrass sod on the bottomlands was broken and crops of spring wheat were grown. Shortly after the turn of the century a change was made to a winter-wheat and summer-fallow system. Cultivation was extended to many of the steeper slopes and the hilltops. It did not extend, however, to the more precipitous and inaccessible areas along canyon breaks, as may be seen by the extensive virgin grasslands which remain today in these locations.

Soils of the area, prairie silt loams, are highly erodible whether they are overgrazed grasslands or cultivated lands, and tend to wash and gully rapidly following depletion of their organic matter. Accelerated erosion under these conditions is a serious problem on both depleted range land and cultivated lands. Drainageways are marked by deep gullies. Rock-strewn "scablands" remain here and there as mute evidence of extensive soil losses.

Excellent stands of native bunch wheatgrass (*Agropyron spicatum*), blue bunchgrass (*Festuca idahoensis*), Sandberg bluegrass (*Poa secunda*), and balsam root (*Balsamorhiza sagitatta*) dominate where grazing has been properly managed or restricted by natural barriers. Brushy areas are, as a rule, confined to the higher elevations and north slopes. Annual grasses and weeds predominate in areas subject to heavy and continued grazing.

Ranges on the north and east slopes enjoy the best growing conditions; they are subjected to a shorter grazing period, and run-off is slower. Early spring grazing on sunny south and east slopes damages them. Unregulated grazing on range lands, coupled with a wheat and summer-fallow cropping system, were the land-use factors under consideration on the cooperator's ranch.

Moderate to severe sheet erosion obtained over the entire grazing area. Very active sheet and gully erosion was in evidence on wheat lands. The vegetal cover was in process of rapid regression from perennial grasses to annual grasses, weeds, and forbs. The carrying capacity of these grasslands was about one-fourth of its original carrying capacity.

No attempt had been made to secure distribution of the livestock by supplying adequate water, salt, and division fencing.

A detailed conservation survey map is presented with this article, showing erosion, land use, slope, and soil types. The planning of this range was based upon a range and economic survey and a study of this map in connection with the land-use and grazing schedule map gives an idea of the problem and the measures initiated to control erosion. The new system was immediately more profitable to this rancher than was his old method of grazing which was fast depleting his pasture and range resources and was setting up critical erosion conditions.

When work was begun the cooperator accepted a complete 5-year soil-improving crop rotation of sweetclover and grass on all the cropland except the areas retired from cultivation and seeded permanently to alfalfa and grass. He also agreed to strip crop, till, and harvest on the contour, and to utilize properly all crop residue. Definite systems for rotational grazing were planned: Unit 1 for the beef cattle; unit 2 for the dairy cows and horses; and unit 3 for the sheep.

The land-use map shown gives the grazing schedule for three units, beef cattle, sheep, and dairy cattle, as planned for this ranch. Under the system adopted the erosion potential will be practically overcome within 3 to 5 years and eventually the rancher's income will be augmented.

The cooperator owns and operates 1,322 acres, of which 373 acres are cultivated and 940 acres are native grass range. He owns 6 horses, 65 cattle (not including calves), 43 sheep, and 30 hogs and pigs. The stock is fed approximately 85 tons of alfalfa, sweet-

[1] Project range examiner, Soil Conservation Service, Dayton, Wash.

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clover, and grain hay, and 683 bushels of barley and wheat during the winter from December 1 until April 15; the dairy cows and pigs are fed throughout longer periods.

In order to provide for a deferred rotation system of grazing on this farm it was necessary to build 450 rods of fence, to develop four springs and to recommend salt site distribution at locations distant from the water and from over-utilized areas. The number of livestock and the periods of grazing were planned according to the estimated carrying capacity for all units of the pastures.

The sweetclover and grass seedings serve as supplemental pasture during the fall on first-year seedings and during the spring on second-year seedings before they are plowed under as a green manure crop.

1938 Grazing Schedule

UNIT NO. I. BEEF CATTLE UNIT

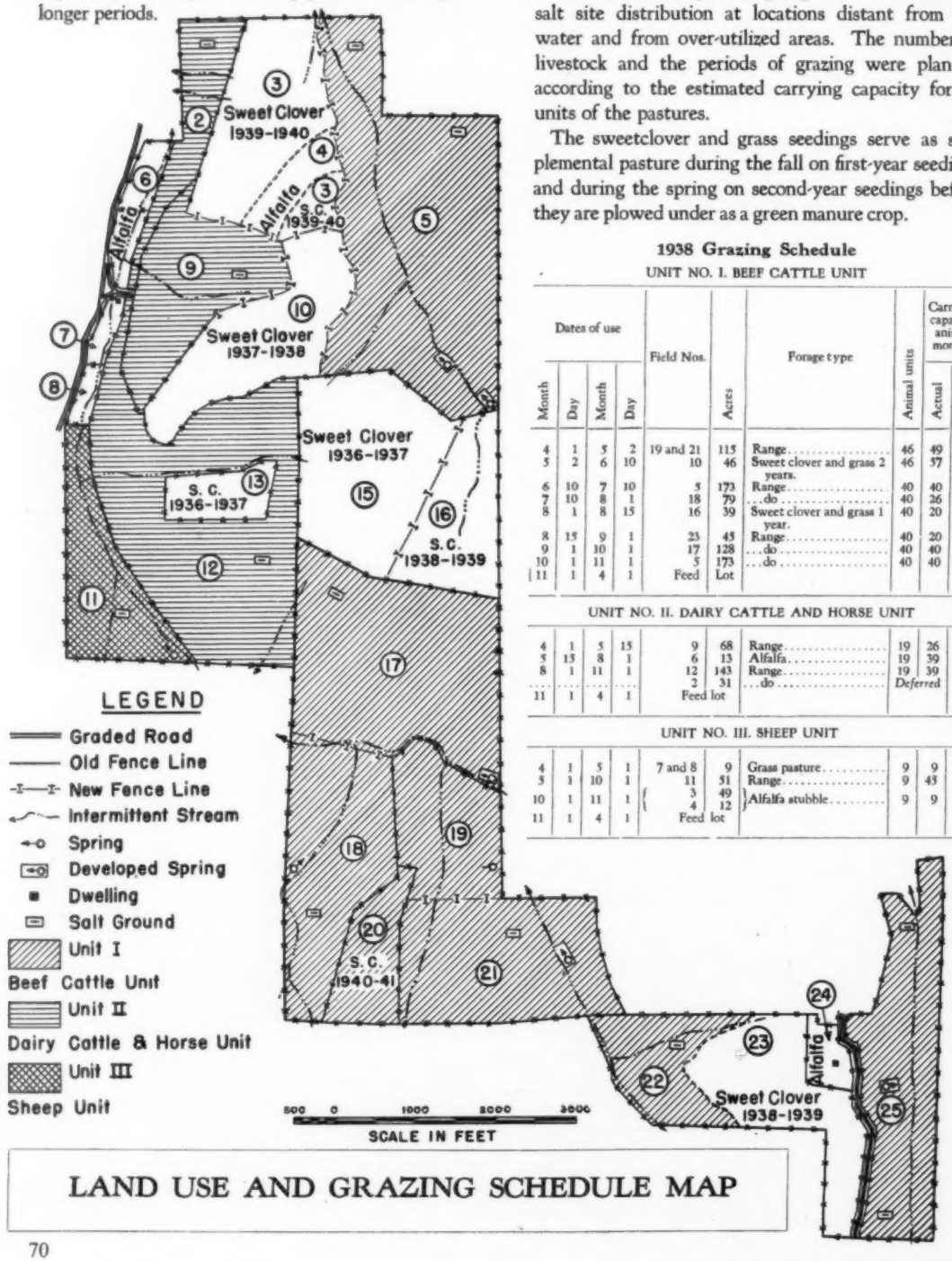
Dates of use				Field Nos.	Acres	Forage type	Animal units	Carrying capacity, animal months	
Month	Day	Month	Day					Actual	Estimated
4	1	5	2	19 and 21	115	Range	46	49	56
5	2	6	10	10	46	Sweet clover and grass 2 years.	46	37	96
6	10	7	10	5	173	Range	40	40	81
7	10	8	1	18	79	...do	40	26	33
8	1	8	15	16	39	Sweet clover and grass 1 year.	40	20	20
8	15	9	1	23	45	Range	40	20	27
9	1	10	1	17	128	...do	40	40	43
10	1	11	1	5	173	...do	40	40	41
11	1	4	1	Feed	Lot				

UNIT NO. II. DAIRY CATTLE AND HORSE UNIT

4	1	5	15	9	68	Range	19	26	26
5	13	8	1	6	13	Alfalfa	19	39	39
8	1	11	1	12	143	Range	19	39	44
				2	31	...do	*Deferred*		
11	1	4	1	Feed lot					

UNIT NO. III. SHEEP UNIT

4	1	5	1	7 and 8	9	Grass pasture	9	9	9
5	1	10	1	11	51	Range	9	45	45
10	1	11	1	3	49	Alfalfa stubble	9	9	9
				4	12				
11	1	4	1	Feed lot					



LAND USE AND GRAZING SCHEDULE MAP

Approximately the same acreage of sweetclover is seeded out each year to ensure sufficient forage, to relieve the range, and to allow rebuilding of the wheat lands by systematic rotation. Excess sweetclover may be clipped and used for hay. The permanent alfalfa and grass seedings produce high quality hay for winter feed, and the crop aftermath is pastured lightly in the fall along with adjoining wheat fields.

Under proper management the range pastures have increased in forage density from 42 to 63 percent in 2 years and the carrying capacity shows an increase of approximately 112 percent. The cattle are in better condition in the fall and are more contented on the range than they were under the old operation. The yearlings show more rapid and economical gains; in 1937 and 1938 they were sold as grass-fat baby beef, off the sweetclover and grass, at top prices.

On the 2d of June the cooperator was interviewed at his farm. A few of his statements regarding the new grazing program will help to show the importance of this cooperative work now being carried out between the Service and farmers and ranchers:

"I had known that my range pastures were not being grazed evenly and that most of them were overgrazed. Now nothing could convince me that the old management was better than the new. The number of livestock on my farm is about the same as it formerly was; I sold some of my horses and bought a tractor, and the diary cattle and sheep herds have been increased. Through the deferred and rotational grazing, and relief from grazing by means of the sweetclover and grass seedings, feed production is greater on my range land, and all the native pastures on my farm have improved especially in the density and height of the bunchgrass. There is less cheatgrass and weeds. The 450 rods of fence which the Soil Conservation Service helped me to build has made it possible for me to protect my rotational and permanent seedings and to divide my pastures for proper management.

"The four springs which have been developed on my farm, together with the salt distribution system, allow the stock to eat the grass evenly over all the pastures. The sweetclover and grass seedings pastured in the spring are a great help in protecting the young grass on the range. Some people claim that their cattle will not eat sweetclover and get fat on it, but our cattle show gain from sweetclover and they like it. I have no trouble from bloat. Throughout the past 2 years, instead of fattening my beef in the feeding lot, I have pastured them on my sweetclover and sold them as grass-fat beef at top prices.

"My sheep did better last winter on alfalfa hay from my permanent seedings than they ever did on grain hay. Small areas that do not fit well with general cropping practices can be seeded to alfalfa and grass for hay and pasture, and they bring profitable returns. Gullies that formerly were uncrossable are now controlled and seeded to alfalfa and grass. They can be crossed anywhere, and the alfalfa is used for hay for my stock."

LIVESTOCK INDUSTRY BENEFITS

(Continued from p. 61)

On badly depleted ranges where most of the desirable perennial grasses have been killed out and stock are depending principally upon annual weeds, such sharp reductions in stocking are necessary in order that the grasses may have a chance to restore their vigor and increase their stand. Without protection from grazing, especially during the growing season, the grasses do not have this chance—they are more palatable than the weeds and are eaten down to the ground as fast as they grow.

There has been a strong feeling among some of the leaders in livestock affairs that increases in pasture acreage resulting from the retirement of cultivated cropland to pasture would cause an increase in the production of livestock and livestock products. This feeling became strongly evident when the original crop-control legislation was put into effect in 1933. It has persisted to a limited extent among dairymen and western stock and wool growers in spite of the fact that approximately 70 percent of the acreage of all crops is used for livestock feed; and that corn, the principal cultivated crop, produces considerably more feed than the same land would produce in grass; that about half of the wheat and cotton crops are used for livestock feed, as bran, cottonseed meal, etc.; and that there has been a marked increase in livestock production concurrent with an increase in crop acreage and a decrease in both pasture acreage and pasture productivity.

A very thorough study relating to this subject is reported in Iowa Bulletin 361, December 1937. The title is "Livestock Production in Iowa as Related to Hay and Pasture Acreage," and the author is Walter W. Wilcox. The following extracts from the text and summary of this bulletin are particularly significant:

"Dairying has been increasing rapidly in Iowa during the past decade in the face of a decrease in hay and pasture acreage. Apparently price relation-

(Continued on p. 74)

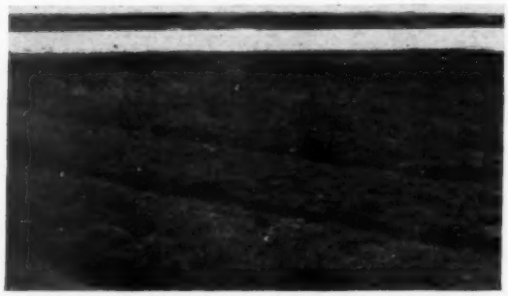
Thirteen Years of Contour Furrows

By D. V. Shuhart [1]

IT was interesting to find in the semiarid climate of Stillwater Creek an acreage of contour furrows which were 8 years old when the Soil Erosion Service started the project in 1933. Contour furrows had been plowed along lines run by an engineer; the furrow slices were turned downhill; gullies had been skipped; furrows were spaced approximately 10 feet apart—these furrows had been plowed for water conservation.

The city of Stillwater, Okla., built Boomer Lake Dam in 1925 for a municipal water supply. The Carter C. Hanner Post of the American Legion, being civic-minded, appointed a committee to work out the details for planting trees on a part of the badly eroded and overgrazed pasture which bordered the west shore of the lake.

It was recognized that the eroded Vernon clay loam was a very difficult site on which to establish trees,



Thirteen-year-old contour furrows surveyed and plowed for water conservation in an unsuccessful tree-planting project on grassland.

especially the bare-rooted 6- to 8-inch Austrian pines which were selected for their availability rather than their adaptability to the site. The trees were obtained from the State forest nursery, and plans were made to use the voluntary labor of public-spirited citizens in planting them. The original scheme was to construct water pockets by slicing off the competing weeds and grass from a 2-foot circle, then leveling off the spot and using this material for a semicircular dam on the downhill side. Some people had observed that during dry years cotton plants in small depressions grew much larger than other plants in the same field—hence the idea for the water pockets.

But the plan presented difficulties because of the type of labor available. Business men not accustomed to such work might tire after the first 10 or 12 water pockets were constructed. It was thus that the idea of contour furrows for moisture conservation was conceived—as a result of consideration for the tender hands and the soft muscles of business men who were to plant the trees.

Prof. R. E. Kirkham, a civil engineer, was asked to volunteer his services to run the lines. Laths were used to stake the lines, which were plowed about 6 inches deep with a 12-inch walking plow. Trees were planted in the furrows which waited to catch and hold the raindrops. Needless to say, the area was protected from grazing.

Are these the oldest contour furrows plowed along surveyed lines in grassland with the idea of moisture conservation definitely in mind? I venture to say that possibly they are. One familiar with southwestern Texas is of the opinion that the increased grass growth noticed on contour furrows at Abilene, in 1899, was in reality an observation of increased growth on furrows plowed for the protection of ranges from fires, a common practice in that area.

Rain did not come in time. Continued drought killed the trees in the summer. The scars left by the

Close-up of head erosion from a 13-year-old contour furrow. Maintenance or furrow-blocking could have prevented this damage.

[1] Section of information, Soil Conservation Service, Salina, Kans.

contour furrows were soon covered with sufficient weeds and grass to hide them. Some burning occurred during the years that followed, but by 1933 the vegetative cover was so dense that the eye of the camera failed to reveal the contour furrows when the aerial photographs of the Stillwater Creek watershed were made.

An unsuccessful attempt to plant this area to pine trees was made again in 1934, but the contour furrows were not observed because of the dense growth of grass. A technician making a soil and erosion map in 1935 failed to notice their presence. They were indeed hidden in vegetation. There they remained without maintenance, for 13 years. They now offer an interesting study in ecology.

Many questions have arisen from time to time concerning contour furrows. Here are four of them: Will the increased water supply in the disturbed furrow cause a succession of forbs? Will water concentrated by furrows, due to slight irregularities in

Washout caused by concentration of water from 13-year-old contour furrows on which no maintenance has been applied.

the contour, cause the formation of gullies? Has contour furrowing improved the cover on areas which were sheet-eroded almost to the C horizon? How does the cover of vegetation on contour-furrowed land compare with that of adjacent soil and slope on which elimination of grazing alone has been practiced? These questions all involve some element of time. Some of them have been answered from a common-sense background, others from results secured over a short period of time.

A critical study of this field which has been contour furrowed for 13 years reveals some interesting points which may contribute something to the answers of these questions.

The removal of grass whether by overgrazing, drought, or by plowing, is quite definitely associated with the succession of weed stages. Contour furrows and contour ridges do permit weeds to grow readily on the disturbed areas, especially when stimulated by increased moisture. It is encouraging to note that

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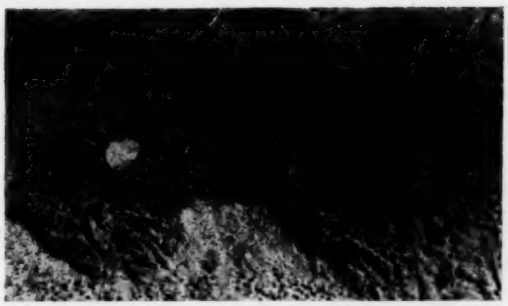
Little bluestem (Andropogon scoparius) is dominant on this part of the 13-year-old contour-furrowed area, although no mowing has been practiced.

newly developed furrowing machines attempt to reduce the disturbance of grass to a minimum.[2] After 13 years of forb and grass competition on the contour-furrowed field, without the aid of mowing, little bluestem (*Andropogon scoparius*) is decidedly dominant in one portion of the field; Indian grass (*Sorghastrum nutans*) is dominant in a second portion; blue-grama (*Bouteloua gracilis*) is dominant in another portion. Fall witchgrass (*Leptoloma cognatum*) is dominant in another, and triple awn grass (*Aristida oligantha*) in still another. Many forbs are present but in no place are they dominant although in certain seasons they may appear to be so because of their conspicuous foliage.



Moss binding the last remnant of soil above the C horizon at the edge of a washout.

One of the greatest hazards of contour farming, level terracing, contour ridging and furrowing is the possible damage from slight inaccuracies in contour lines—these inaccuracies cause water concentration. Concentrated water, put in motion by breaks at points where vegetation is sparse, will form gullies. At one point in this field the contour furrows crossed a slight depression which was easily skipped by the instrument when the lines were run. The soil at this point was shallow and the cover of vegetation was

[2] Bloom, Merle W.: Contour Furrows Constructed Without Loss of Sod. SOIL CONSERVATION, October 1937, p. 105.

barely sufficient to check normal sheet erosion. Water concentrating in the furrows overtopped them and a gully was started. Each furrow contributing water to this spot developed an overfall at its mouth. Curiously enough, the furrows below this area caught and held all material washed from above and the lower end of the eroded spot has become completely grassed over. The soil along the edges of this area is being protected from more rapid erosion by a moss which covers it from the A to the C horizon. Head erosion in each furrow has widened the gully with the result that it now presents the appearance of a typical alkali spot. This damage could have been avoided by maintenance or by the use of small dams across the furrows.

The importance of these small dams cannot be overemphasized. Damming attachments on listers and more recently on furrowing machines [3] indicate that some attention is being given to this most important consideration, but it is still too common that one may sight along the top of a contour furrow without dams and observe ups and downs which water in seeking its level cannot follow.

A part of the field was sheet-eroded almost to the C horizon when the contour furrows were constructed. Some scattered triple awn grass was on this area at that time. Now, after 13 years, triple awn grass is still present. In one place in this area, it has formed a dense cover and is decidedly dominant. A few scattered clumps of silver beardgrass (*Andropogon saccharoides*) and fall witchgrass are found among the triple awn. The contour furrows can be traced by the Indian grass growing in them. In the other part of this area triple awn grass has been practically replaced by fall witchgrass which, being perennial, may prove to be an important intermediate stage in the succession from triple awn grass to the short grasses. In this second portion, however, little bluestem occurs in or near many of the furrows, indicating that this grass rather than the short grasses may follow fall witchgrass.

Belt transects and quadrat studies have been planned but have not progressed far enough to answer definitely our final query. Preliminary observations indicate, however, that the cover of vegetation developed by each major species on the contoured area is decidedly greater than that developed on an adjoining area of like slope, soil, and history. Little bluestem is denser on the contour-furrowed part of the field than in any comparable area in the field. Indian grass also is very noticeable—that on the contoured field is taller and thicker than that on any comparable area. Apparently more blue grama is present in the contour-furrowed field. Triple awn grass on the badly eroded land crossed by the 13-year-old contour furrows appeared much thicker than that on similar sites not furrowed. The one grass which seemed to be just as dense on the check area as on the contoured field was fall witchgrass, which because of its nature of growth may be more difficult to judge by a preliminary observation.

The conclusion based on unbiased judgment of results, taking into consideration the value of cover for erosion control, the economic value of the vegetation, and the possible damage preventable by proper maintenance, is that the contour furrows have been well worth while.

[3] Querns, Glenn M.: 620 Miles of Contour Furrows Stabilize the Pocatello Hillsides. SOIL CONSERVATION, January 1938, p. 171.

LIVESTOCK INDUSTRY BENEFITS

(*Continued from p. 71*)

ships (butterfat prices as compared to feed prices and the general price level of other Corn Belt products) have been the dominant factor influencing the expansion of dairying in Iowa in the past; they probably will continue to be.

". . . Moreover, it appears that when the farmers have plenty of grain they feed considerable quantities of it to other than their fattening cattle. If grain becomes more scarce, it may take considerably more roughage to grow the present number of cattle in Iowa. Also, uniformity of range cattle makes them favored over the 'native' feeders by the commercial cattle feeders. In view of these conditions it would appear that the future demand for range cattle will be more closely related to market price trends than to crop acreage changes."

It has been observed in all parts of Iowa that the farms having more than the average amount of grass have more livestock of all kinds than farms having less than the average amount of grass. But it does not follow that decreasing the corn acreage and increasing the pasture acreage in Iowa will increase the total livestock production of the State and other areas to which Iowa now ships feed.

The following findings, based on an analysis of the data presented in this bulletin, are of particular significance in the development of a soil conservation program for the Corn Belt:

"Moderately increased acreages of soil conserving crops may be expected to have little effect on total feed production in the State, except over a long period of time, tending to maintain it at a higher level than would be possible if present depletion is allowed to continue, especially on the highly erodible soils."

Problems Affecting the Establishment of Grass in the Great Plains

By C. R. Enlow [1]

DURING recent years it has been increasingly difficult to obtain successful results from the seeding of grasses, legumes, or mixtures for permanent pastures, meadows, waterways, and terraced outlets, particularly in the eastern portion of the Great Plains States and sections of Iowa and Missouri. Although the Service has been working directly with thousands of farmers, following the best recommendations of the State experiment stations, in general the results have been disappointing.

RECENT publications by the Illinois Farmers' Institute,[2] the Weather Bureau,[3 4] and the Soil Conservation Service, U. S. Department of Agriculture,[5 6 7 8] present some extremely interesting data regarding the trend of precipitation in the region outlined above. Examination of this literature and additional calculations from weather bureau records, reveal a rather striking point, namely, that at several weather stations the precipitation has shown a varying downward trend since weather recordings began (*graphs A, B, C, D*). While there is no reason to expect the downward trend to continue, present conditions must be recognized as they are of considerable significance to agronomists and others interested in the successful seeding, growing, and harvesting of crops.

It has been pointed out [7] that precipitation is due almost altogether to moisture carried by enormous air masses of marine origin as it is precipitated when cooled by contact with air masses originating in polar regions. From this it becomes apparent that man's activities on the land can have little if any effect on precipitation. Likewise, some individuals have surmised that the enormous wheat acreage of past decades (*graph E*) in Kansas, Nebraska, and adjoining States is partly responsible for decreased precipitation. Apparently this theory also is incorrect. Farming practices, such as plowing up and down hill and leaving the soil with inadequate cover, have greatly increased the rate of run-off. As a result, a smaller proportion of the rainfall has been available for crop production, thereby accentuating the effects of reduced rainfall.

There has been a tendency to blame unsuccessful seedings on the particular weather conditions and grasshopper invasions, and rightly so. But it becomes apparent that losses of organic matter, topsoil and moisture, through oxidation, erosion and increased run-off must also be considered; in addition, we must give our attention to the downward trend in precipitation and the upward trend in summer temperatures (*graphs F, G, H, I*). With lessened precipitation, it seems logical that summer temperatures should be higher in this region of not too abundant rainfall, as green vegetation becomes scarce during extended dry periods. The cooling effect of transpiration is lost when vegetation is no longer green and growing.

The author has for many years been interested in seed mixtures for grasslands and the recommendations of State and Federal agencies regarding the same. A study conducted several years ago indicated that the majority of seed mixtures recommended are largely based upon theoretical considerations and are not the result of experimental work. This statement is not meant as adverse criticism, as the physical limitations in conducting field tests with mixtures, involving several grasses and legumes, are readily recognized.

Many of the mixtures now in use are based on observations made over a long period of years. In the

[1] Principal agronomist, Soil Conservation Service, Washington, D. C.

[2] Kincer, J. B. Is our climate changing? Ill. Farmers' Inst. 1937–1938.

[3] Reed, Charles D. Secular trend of Iowa precipitation. Reprint from Monthly Weather Rev. v. 58, pp. 139–142. Apr. 1930.

[4] Mattice, W. A. Precipitation in the Northern Great Plains. Reprint from Monthly Weather Rev. v. 62, pp. 445–447. Dec. 1934.

[5] Thornthwaite, C. Warren. The Great Plains. Offprinted from Migration and economic opportunity, Chapter 5, pp. 202–230.

[6] Thornthwaite, C. Warren. The life history of rainstorms: Progress report from the Oklahoma Climatic Research Center. Reprinted from The Geographical Rev. v. 27, No. 1, pp. 92–111. Jan. 1937.

[7] Holzman, Benjamin. Sources of moisture for precipitation in the United States. U. S. Dept. Agr. Tech. Bull. 589, Oct. 1937.

[8] Thornthwaite, C. Warren. The hydrologic cycle re-examined. Reprinted from SOIL CONSERVATION, v. 3, No. 4. Oct., 1937. pp. 1–8.

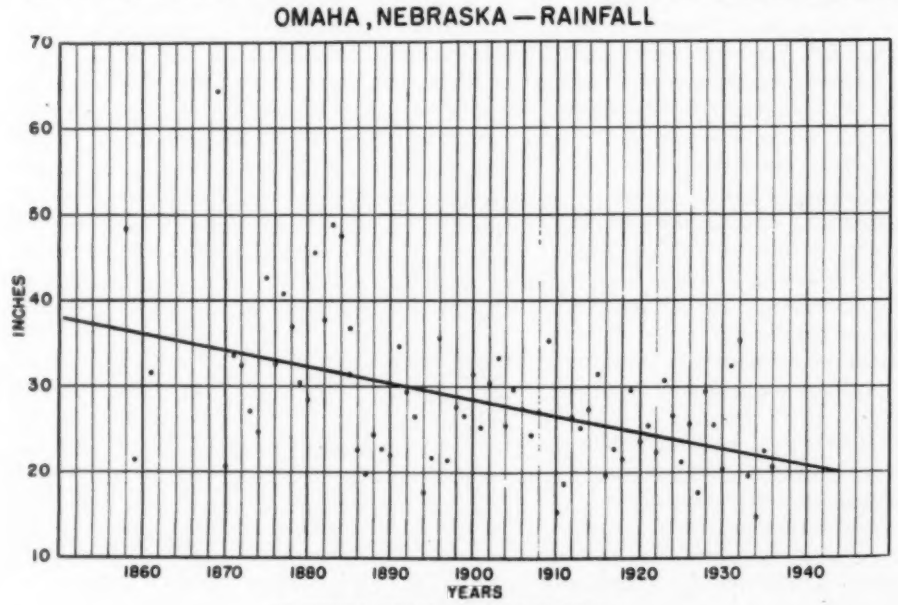
case of the area under discussion, there is a distinct change of conditions, brought about by decrease in rainfall and increase in summer temperature; we cannot hope for identical results, under present conditions, from seedings of the mixtures of 25 years ago. Furthermore, the organic matter in the soil has been depleted, so that moisture is not retained by the soil in the quantity nor for as long a period as it formerly was. Erosion has removed much of the fertile topsoil, and run-off is accelerated. With less rainfall, higher temperatures and the consequent higher evaporation, less storage for water in the soil, and a higher percentage of loss of the rain through run-off, we can scarcely expect the seed-mixture recommendations made some years ago to be applicable to present conditions.

To illustrate the point in question, let us refer to graphs A, B, F, and G. In 1910 the average precipitation at Topeka, Kans., according to the trend line, was 32.6 inches and the high temperature was 101.8° F. In 1935 these figures had changed to 31.4 inches and 105.6° F. At Omaha, Nebr., in 1910 the average precipitation was 26.3 inches and the high temperature was 100.4° F. In 1935 the readings showed 21.9 inches and 103° F.

The Nebraska Extension Service [9] in 1933 recommended the following seed mixture for permanent pastures:

Mixture:	*Pounds per acre*
Bromegrass	7
Orchard grass	4
Timothy	3
Red clover	4
Sweetclover	4
Meadow fescue	3
Total pounds per acre	25

[9] Stewart, P. H., and D. L. Gross. Permanent and temporary pastures for Nebraska. Nebr. Ext. Circ. 102. pp. 1–15, Reprinted, Aug. 1933.



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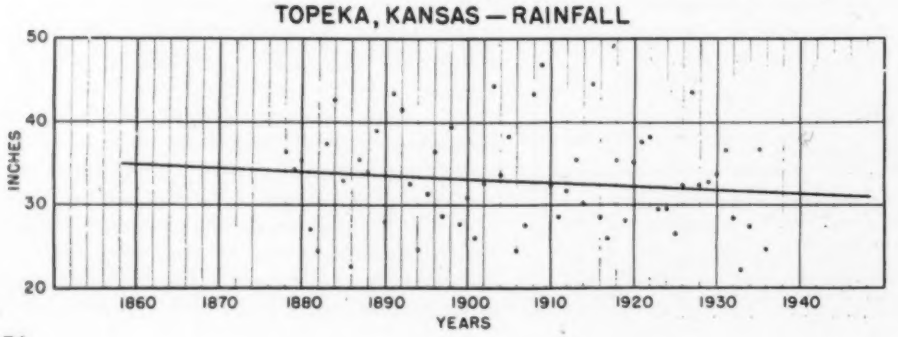

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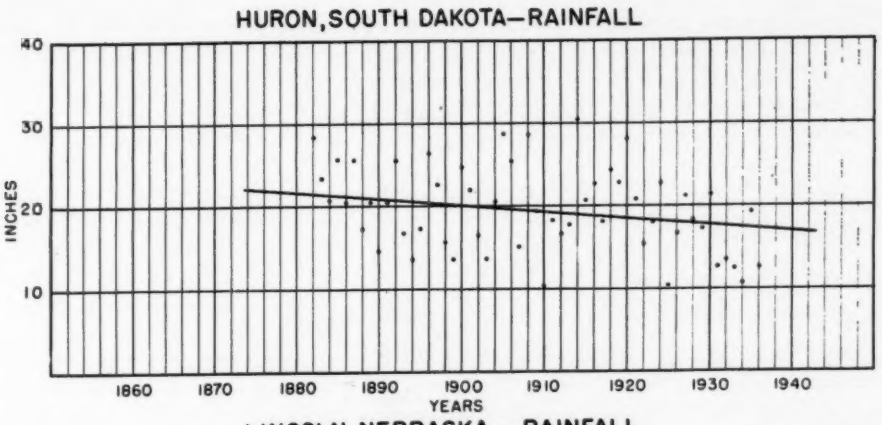
HURON, SOUTH DAKOTA—RAINFALL
INCHES
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30
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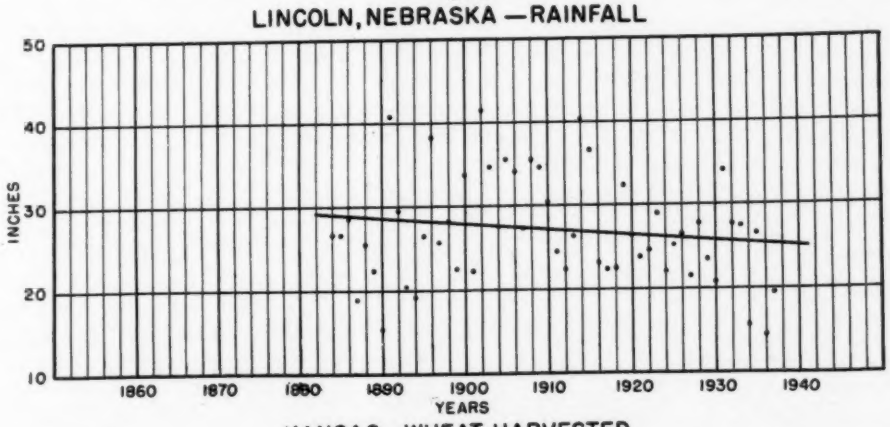
1870
1880
1890
1900
1910
1920
1930
1940
YEARS

D


LINCOLN, NEBRASKA —RAINFALL
INCHES
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YEARS

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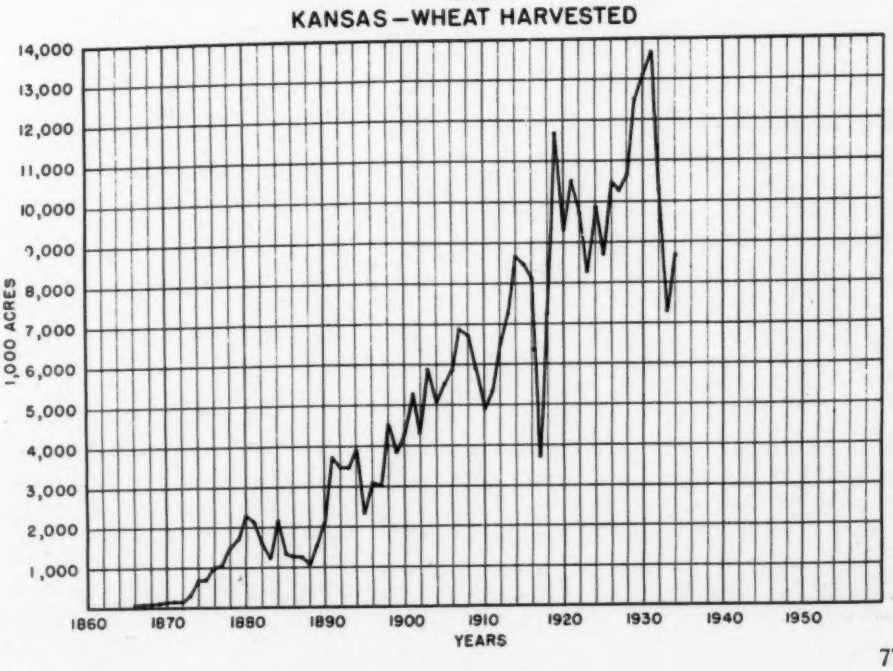
KANSAS—WHEAT HARVESTED
1,000 ACRES
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13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
YEARS

The Kansas Experiment Station [10] in 1931 recommended the same mixture with some variation in percentage of composition, and with Kentucky bluegrass in addition for northeastern Kansas. The recommendation for east central Kansas was as follows:

Mixture:	Pounds per acre
Redtop	6
Orchard grass	6
Meadow fescue	6
Kentucky bluegrass	2
Alsike clover, white clover, or sweetclover	4
Total pounds per acre	25

Examination of seedings based on these and similar recommendations made the past three years on many farms in eastern Nebraska and Kansas reveals a very disappointing situation. In many instances the seedings were total failures. In most other cases some bromegrass and sweetclover survived, but the stands are very poor. The Nebraska station has recognized the difficulty of obtaining good stands from the above mixtures, and, as a consequence, recommendations for the eastern part of the State were changed, in March 1938,[11] to the following:

Mixture:	Pounds per acre
Bromegrass	14
Alfalfa	4
Total pounds per acre	18

or the mixture shown below:

Mixture:	Pounds per acre
Bromegrass	10
Timothy (or orchard grass)	4
Alfalfa	2
Sweetclover	2
Total pounds per acre	18

The Kansas station has also changed mixture recommendations considerably in view of the adverse conditions encountered in recent years. The following mixture is now recommended for average soil conditions in eastern Kansas:

Mixture:	Pounds per acre
Bromegrass	8
Orchard grass	6
Meadow fescue	4
Korean lespedeza (acid soils) or sweetclover (non-acid or limed soils)	4
Total pounds per acre	22

It is encouraging to note that the State experiment stations are attempting to meet changed conditions by modifying seed mixture recommendations; this indicates a general recognition of the greatly changed conditions for the seeding of grasses and legumes in the eastern Great Plains. Actually, a majority of the weather station records from central North Dakota to central Texas and from eastern Colorado to eastern Iowa show a downward trend in precipitation, although not as marked as at Omaha, Nebr. Changes in summer temperatures are also noticeable, and because of loss of organic matter and topsoil, soil conditions are considerably different.

The Soil Conservation Service is launched on a Nation-wide erosion control program in which vegetation plays a major part. The very best information available must be used by Service agronomists, and it is essential that we work very closely with technicians of the State experiment stations. It is highly important that we have their advice in the field where results can be observed; and suggested changes in mixtures, tillage and seeding operations should be discussed freely. The possibility of elimination, from mixtures of those grasses and legumes that are failing to give results, should be discussed both from the standpoint of obtaining results and as to economy. It is wasteful to plant seeds that do not give results.

Considering recent developments in harvesting seed of native grasses, it may be possible to rely to a considerable extent on these developments in deciding upon mixture seedings for the region under discussion, provided practical seeding methods can be developed, and results to date are rather encouraging. It seems apparent that a firm seedbed with a trashy surface offers much better opoortunity for the establishment of a good stand than does a clean seedbed, regardless of the thoroughness with which the soil has been prepared. The mulch of wheat stubble, weeds, crabgrass, and other trash offers excellent protection to the emergence and survival of the seedlings. The mulch prevents formation of a soil crust, retains surface moisture, and offers protection against excessive sun and wind. When moisture is plentiful and grasshoppers are not too numerous, early fall planting is a good practice. Late fall planting in wheat stubble gives excellent results in some places, particularly where grasshoppers are too plentiful for early fall planting; the seedlings get a very early start in the spring. Spring seedings are sometimes successful, but are more subject to periods of drought and to grasshopper attack.

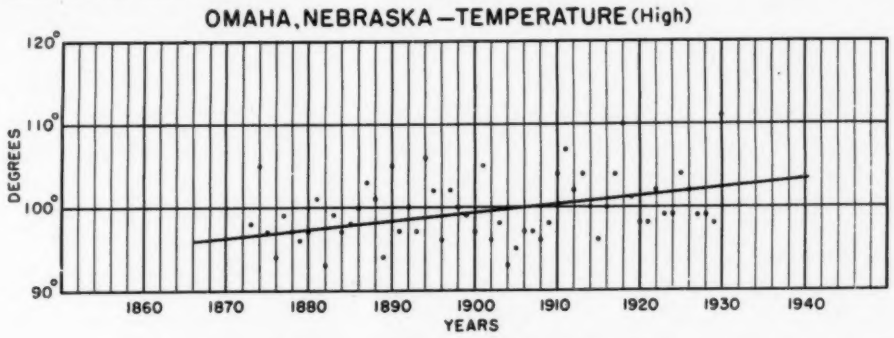
Agricultural experiment stations have been seriously handicapped for lack of funds to study grasses and grass problems. More information has been secured in the past few years than in many years previous, and it is hoped that the material presented here will

[10] Aldous, A. E., and J. W. Zahnley. Tame pastures in Kansas. Kans. Agr. Exp. Sta. Bull. 253. Jan. 1931.

[11] Frolik, A. L., and E. F. Frolik. Seeding and management of Nebraska pastures. Nebr. Ext. Circ. 138. March 1938.

point out the serious need for additional information. It is becoming increasingly evident that a truly permanent agriculture calls for more extensive use of grass, to maintain or improve the organic matter in our soils, and to prevent actual loss of our soils through erosion.

F



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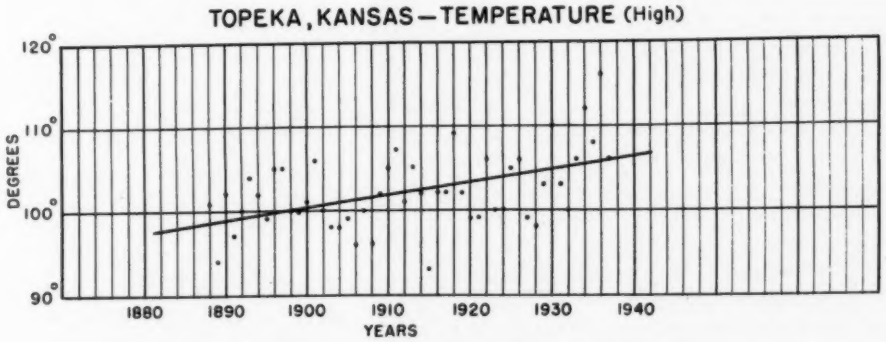

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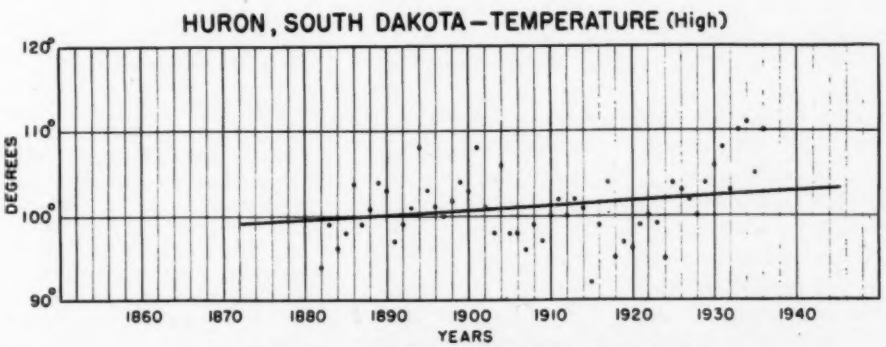

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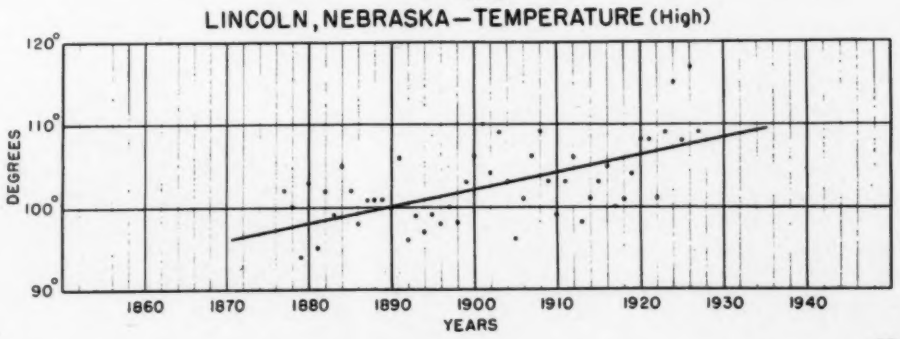

Economic Units for the Dust Bowl

By W. R. Watson[1]

IMPROPER land use, abandonment of farm lands, short-term land tenure, and the economic condition of present operators are important and limiting factors in planning a complete soil and moisture conservation program in the Dust Bowl and bordering areas. Much of the grassland of the southern Great Plains was put into cultivation during years of excessive moisture and high commodity prices. This transition from grazing to farming caused land ownership to pass into the hands of small owners and operators, many of whom were nonresidents. Very few of these individual land ownerships constitute economic units that are practical and adaptable to the area. This fact, combined with the successive years of drought, has caused a very high percentage of abandonment in the Dust Bowl area.

Irresponsible operations on these nonresident owned lands is one of the principal causes of the inception and continuance of the wind erosion hazard. The general practice in the past was for lessees to operate on a year-to-year basis. This short-term land tenure is not conducive to the adoption of sound conservation practices. Cultivated fields are neglected and allowed to blow. Pastures are overgrazed and damaged under this system of land use. Because of successive crop failures many of the land operators remaining in this area are financially unable to put into effect the practices necessary to control wind and water erosion.

The foregoing conditions have hindered the furtherance of a sound program for the Farm Security Administration as well as the Soil Conservation Service in this area. Realizing the urgency of the situation and the necessity for certain adjustments in the Dust Bowl area, if land abuses are to be stopped and if those who need assistance are to be rehabilitated, the Soil Conservation Service and the Farm Security Administration are now cooperating in a joint program.

The principal objectives of this cooperative program may be summarized as follows: To establish economic units by consolidating several small ownerships of land into one unit of sufficient size to maintain a family on a satisfactory basis while following a type of agriculture adaptable to the land of that area; to con-

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The former occupant of this adobe house on a 320-acre farm in Eastern Colorado farmed up and down hill and depended upon "open range" for pasture for his work horses and milk cows. He did not establish reserve feed supplies. His principal income was from cash crops which, during recent drought years, proved insufficient. He found it necessary to supplement his farm income by working on relief work projects. The farm is not regarded as an economic unit for the area.

On another 320-acre farm in the vicinity is the house pictured below—its occupant, the former resident of the adobe dwelling. Here, too, was once an uneconomic unit, with cash crops, livestock and "open range" the main reliance. The man sold his cattle, left the place, principally because he did not control sufficient range lands for his needs.

Through cooperation of the Soil Conservation Service and the Farm Security Administration the present tenant has obtained long-term leases on 2,240 acres of non-resident owned pasture lands adjoining. What was formerly "open range" has now been fenced. Soil and moisture conservation structures, including contour furrows and stock dams, have been installed. Ninety-two acres of cropland have been terraced. All farming is on the contour, with emphasis on the production of feed crops. A two-year feed reserve will be stored at the first opportunity. The operator has purchased a foundation herd of cows, being financed by the Farm Security Administration under a 10-year repayment plan. It is felt that more security has been added to this man's operations and that this reorganized economic unit should provide an adequate income for himself and his family.

trol, through lease or otherwise, the lands in the unit for a sufficient length of time to justify the operator in making improvements in the soil and to give permanence to his enterprise; to include in the operating unit and to restore to grass the adjacent abandoned marginal cropland not needed for crop production by other operators; to adopt and put into effect on the lands of the unit the soil conservation practices necessary for a complete program of soil and moisture conservation; to place principal emphasis on the production of livestock and feed crops and to minimize the production of cash crops in that area.

In order to carry out the objectives of this program several Soil Conservation Service technicians have been detailed to unit reorganization work to cooperate with Farm Security Administration officials. The Service technicians are assigned these special duties: To obtain long-term leases on small ownerships of contiguous lands, and to consolidate these leaseholds into one operating unit of sufficient size to justify livestock and forage-crop production as the major enterprises; to work out farm management plans for the unit as established, and to plan a complete soil and moisture conservation program for the lands involved. All planning is predicated upon a 10-year program for the unit operator. Planning the size and type of unit to be developed requires the closest cooperation of the Farm Security Administration and the Soil Conservation Service. The unit, as developed, must fit the needs and capabilities of the Farm Security Administration client, and at the same time be so planned as to conform to the principal objectives of the program.

As soon as a unit which is acceptable to the Farm Security Administration has been established a complete plan of conservation operation, based upon conservation and range surveys, is drawn up by the Soil Conservation Service technicians. Into this plan of conservation operations is incorporated a 10-year agronomic, range, and land-use program. Where erosion-control structures are needed, to be built by the operator, the specifications and dates of construction are definitely stated. This plan of conservation operations, signed by the operator, then becomes a part of his Farm Security Administration loan agreement and farm plan.

Loans are then made by the Farm Security Administration. The livestock loans are repayable over a 10-year period. This long-term loan policy makes it possible for the client to establish himself with a foundation herd of livestock. As the marginal croplands, which are being restored to grass in the unit, become revegetated and increase in livestock carrying capacity, this foundation herd can be increased to the numbers necessary for an economic unit. Forage crops produced on these units are stored for reserve feeds at the first opportunity, so that a balance between feed production and consumption may be maintained over periods of unfavorable moisture conditions. This long-term planning and financing is an impossibility unless long-term tenure is first established.

Many obstacles are encountered in the organization of the economic units. For example, taxes, based upon cultivated land values, are too high in many communities to justify use of the land for grazing purposes. This is particularly true of the restoration land which has little value at first for grazing. Nonresident owned lands are in many cases held for speculative purposes. The owners are concerned only with sub-surface rights and not with surface erosion problems. Leases, in the past, have usually been made from year to year. Land owners who wish to dispose of the holdings do not wish to obligate themselves for more than 1 year at a time. Land investments have in many instances been made on the basis of productive cropland. A great deal of land in this area is owned by speculators who are waiting for favorable moisture conditions to dispose of their holdings as cropland. In certain areas there is little or no grassland left to be used as the basis of support for the foundation herd. In other areas much of the nonresident owned and abandoned land has virtually reverted to "open" range. This "open" or "free" range is generally used by large operators, many of whom are transients. Naturally, this class of operator does not favor a program in which one of the basic principles is controlled grazing, which in turn implies fencing of ranges. A program based upon a livestock economy does not offer the speculative possibilities that a cash crop offers. Many farmers in the area are still waiting for that one bumper crop to cure all their economic ills, forgetting that in the interim, with continued erosion, their chances of growing that crop are being reduced each year.

In spite of all of these major obstacles and many others of local or minor importance, a great deal of progress has been made by the Soil Conservation Service and Farm Security Administration since this cooperative program started in 1938. Most farsighted operators in the Dust Bowl realize that the area is primarily adapted to livestock and forage-crop production; and the majority of the Farm Security Administration clients, or those who are eligible for

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Roads Open—and Farms Secure

An Arkansas highway with vertical banks and sharp ditches.

The same highway as above, after roadside cuts were sloped and sodded for erosion control, safety, and beautification.

By Arnold Davis [1]

HIGHWAY right-of-way erosion-control projects and demonstrations being carried on in Region 4 now include 6 demonstrations on State and Federal highways, 12 protective projects on State and Federal roads, and 28 protective projects on county roads. Of these totals, 3 demonstrations, 9 protective projects on Federal and State highways, and 19 county protective jobs are being completed by camps and projects in the Region 4 sector of Texas. Two demonstrations, 3 protective projects on State and Federal highways, and 7 county protective jobs are located in Arkansas. One demonstration on a Federal highway and one county protective project are located in Louisiana.

According to Louis P. Merrill, regional conservator, farmers, highway engineers, and the traveling public now recognize that highway erosion damage is caused by deposits of soil washed from adjoining farm lands and by direct erosion of cuts, fills, and embankments. The presence of raw, unprotected gullies and ditches along highways leads to the eventual destruction of farm land by continuous caving and spread of ditches

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into farm fields. Spread of roadside ditches produces gullies in farm fields and necessitates the frequent relocation of fences paralleling the road. The ditches also spread toward the highways, threatening to undermine the roads. This raises highway maintenance costs.

Control programs now being effected make use of two methods—vegetation for cover and mechanical structures. Soil-holding grasses, shrubs, and vines are planted in erodible spots along the roadway. Deep ditches are eliminated by resectioning the right-of-way—by sloping and filling the ditches to produce wide, shallow waterways covered with sod or other stabilizing vegetation. Extensive use is made of the drop inlet culvert which protects fills and embankments and cuts down soil washing on adjoining farms.

The demonstrations were set up to determine the most practical and economical methods of roadside erosion control, and to point the way for cooperation among individual farmers and highway departments and county road officials.

"Farmers have been quick to realize that roadside protection work increases the value of their lands, reduces the erosion hazard threatening adjacent fields, and provides a safe, vegetated waterway on which they can empty terrace water," Mr. Merrill said.

The protective work also reduces the traffic hazards, ensuring safer motor travel over the protected routes.

The roadside protection work on a State highway north of Forrest City, Ark., may be cited as an example of projects which have received the approval of landowners and farm operators.

Before work was started on this 2½-mile stretch of road, in the fall of 1937, vertical banks of ditches on both sides of the highway ranged from 2 to 15 feet deep, and erosion was advancing at an alarming rate. Fences bounding farm fields all along the road were dropping into the ditch as caving continued. It is estimated that 12,000 cubic yards of soil had been washed away from the section since the construction of the highway in 1934.

Protective improvement eliminated ditches and substituted a wide, shallow, sod-protected waterway of gentle slope. Farmers along the stretch donated the additional right-of-way needed. Ditch banks were caved in, fills were made and the sloping right-of-way was extended back a few feet into farm fields.

V. O. Turner, who operates a 1,488-acre farm, part of which lies along the section of road which is being protected, said that it would have been necessary for him to move fences back frequently if the road work had not been instituted. "My land was caving off in the ditch all along the road. This was happening in spite of the fact that my pastures over which the water flowed before reaching the ditch caught and held most of the rainfall," he said.

Commenting on a county road project nearing completion at Heber Springs, Ark., W. B. Farmer, who owns 60 acres adjacent to the 2-mile road stretch being protected, said:

"This roadside work has been worth more than $300 to me alone. Before it was done there were times when cars couldn't get through because rains washed draws in the road. It was dangerous to pass another vehicle on the road because of the ditches on either side. The work has helped to eliminate the mud, because water doesn't stand in the depressions. The ditch was cutting into the road all the time, making it narrower.

"Grading helps a road, of course, but grading can't stop it from washing away. It takes good heavy sod to check the cutting power of the rainfall. The sodding done along this road will make it possible for the water to run off without doing any damage. It'll keep the road from washing out."

Maintenance costs along this stretch of highway were high prior to protective treatment. Primary maintenance now consists of periodic mowing by the farmers who till the land adjacent to the highway. The protective work makes it possible for the farmer to harvest a hay crop, in addition to controlling erosion on farm land and highway.

The Arkansas Highway Department announced recently that right-of-way protection of the same type as that used on the demonstrations will be used on long road stretches now under construction. An instance of this is the 50-mile stretch between Monticello and Jonesboro. Engineers announced that banks will be sloped to provide a maximum grade of a 1-foot drop in each 3 feet and will be sodded to prevent erosion.

GRAZING PROGRAM IN DRYLAND SECTION

(Continued from p. 68)

mately one mile of fence to eliminate stock trespass and give exclusive use and control of the grazing to the cooperator.

This type of program on livestock ranches is receiving much attention from ranchers in this area. Together with the aid of the county agents and the A. A. A. range program, it is serving to educate the ranchers, to make them conscious of the grazing problems on their ranches and anxious for help in solving them.

The Native American Lespedezas[1]

By A. J. Pieters[2]

TWENTY species and several varieties of lespedeza have been described from the United States. Of these, eleven species are widely distributed and any one of them may be found anywhere in Regions 1, 2, 3, 4, 5, and in the eastern part of Region 7. In addition, two other species have a more limited distribution, *L. leptostachya* having been reported only from Region 5, and *L. simulata* while occasionally found in the East being confined mainly to Missouri and Oklahoma.

The value of these native species for erosion control has not been determined. In the wild state they are seldom found in close stands, but rather as single plants or as small groups of plants. Growth of this kind is of little value for erosion control but it is possible that some means may be discovered by which good stands may be obtained. One man in Alabama claims to have secured a good stand, but practically no other work has been done with these species. Most of them have been grown by the Bureau of Plant Industry on the Arlington Farm nursery where it was necessary to scarify the seed before stands could be secured.

The seeds of lespedeza species are known to be of some importance as food for birds, especially quail, and they may therefore be useful in wildlife plantings. All the species inhabit rather dry and barren situations, the edges of woods, gravel banks, and pine barrens being frequent habitats.

The object of this discussion is to call attention to these lespedezas, to attempt such nontechnical description as will be usable, and at the same time to point out the distinguishing features of at least the more common species. Only the eleven most common species will be described. The others resemble so closely some of the species described that it would be difficult or impossible to distinguish them by a nontechnical description and nothing would be gained by doing so.

[1] The May 1938 issue of SOIL CONSERVATION carried an article, "Lespedeza Relationships" by Dr. Pieters.

[2] Principal Agronomist, Soil Conservation Service, Washington, D. C.

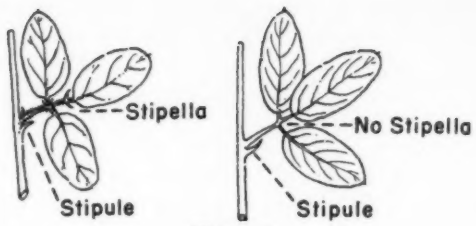

Figure 1.

Before discussing the lespedezas, it may be well to point out that this group is closely related to the beggar weeds, the small-leaved species of which might be mistaken for lespedezas when no flowers or fruits are present. The two groups are readily distinguished, however, by the small growths called stipellas at the base of the leaflets. Both beggar weeds and lespedezas have stipules at the base of the leaf, but only the beggar weeds have the stipellas at the base of each leaflet. This may be clearly seen by the drawings shown in figure 1.

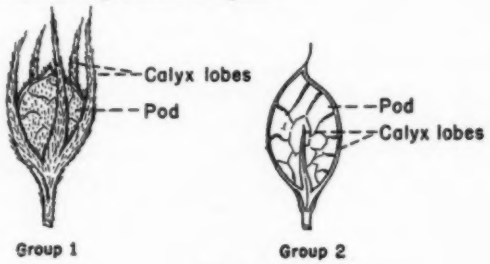

Figure 2.

L. striata and *L. stipulacea*, the introduced annual species which are common everywhere as far north as southern Illinois and Indiana, and *L. bicolor*, an Asiatic perennial which is occasionally found as an

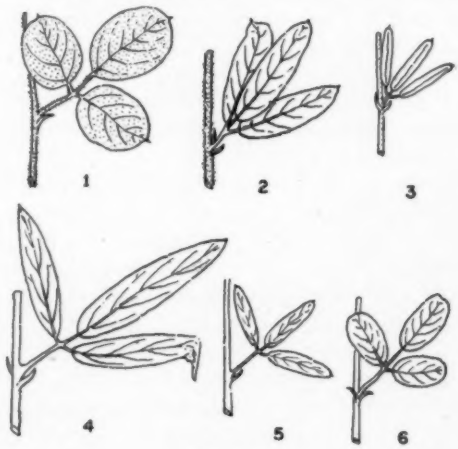

Figure 3.

escape in the South, are not natives of America and are not discussed here. Our native species fall into two groups: those with one kind of flower and those with two kinds. This character is not easy to use, but fortunately it happens that two other characters readily seen are associated with this, namely, flower color and length of the calyx lobes in relation to the flower and pod. Figure 2 shows the relative length of calyx and pod. Let us then divide the species into two main groups as follows:

Group I.—Flowers yellowish, lobes of the calyx about as long as the flower and longer than the pod. Pods very hairy.

Group II.—Flowers red or purple, calyx lobes about ⅛ to ½ as long as the pod (except *L. simulata*). Pods little or not at all hairy.

To Group I belong *L. hirta* and *L. capitata* with the closely related species *L. angustifolia* and *L. longifolia*. All the others belong to Group II. In this group, *L. simulata* is exceptional in having long calyx lobes and a hairy pod, but the flowers are purple.

In Group I, *L. hirta* is readily distinguished from *L. capitata* by its broad rounded leaflets. In fact this species is the only lespedeza having broad rounded leaflets and without hairs on the upper surface but hairy below. Drawing 2 of figure 3 shows the shape of the leaflets. *L. hirta* is a tall coarse growing species 4 to 5 feet high and often well-branched. The flowers are borne in long dense spikes on stalks longer than the leaves. In *L. capitata* the flowers are borne in dense clusters at the end of the main stem or on short branches near the top of the stem, and the stalk of each cluster is shorter than the leaves. The leaflets in *L. capitata* are oval or long, from two to five times as long as broad, and very hairy below—often so hairy as to be silvery. This species usually has but a single stalk which may be somewhat branched at the top but is often quite unbranched.

In *L. angustifolia* the flower clusters are borne on long stalks and the leaflets are long and narrow, several times as long as wide. In *L. longifolia*, the leaflets are very long and evenly narrowed toward both ends, the tip acute.

Of the species in Group I, *L. hirta* would appear the most promising for erosion control. The others usually afford little ground cover.

The species in Group II may be divided and described as follows:

PLANTS PROSTRATE:

Stems nearly smooth or with appressed hairs..... *L. repens.*
Stems with spreading hairs..... *L. procumbens.*

PLANTS ERECT:

Flower cluster open, on long stems few in a cluster, stem smooth or slightly hairy.... *L. violacea.*
Flowers in clusters, on stalks longer than the leaves, stems hairy..... *L. nuttallii.*
Flower clusters dense, sessile or nearly so in the leaf axils on the upper part of the stem or often for a considerable distance down the stem:
  Leaflets narrow, same width throughout..... *L. virginica.*
  Leaflets broad, usually not more than twice as long as broad:
    Leaflets thin and with few hairs..... *L. frutescens.*
    Leaflets very hairy, often silvery..... *L. stuvei.*

L. simulata is so much like *stuvei* that it is difficult to distinguish when not in flower. It is rare in the East but more common in Missouri and Oklahoma. The two species in the prostrate group are distinguished by their habit of growth which is trailing. They sometimes make a dense growth three to four feet in diameter. They are much alike and both occur everywhere, but *L. repens* has a stem only slightly hairy while that of *L. procumbens* is rough hairy. A third species, *L. texana*, is said to differ from *L. repens* in its larger pods and leaflets, but there is doubt that this distinction will always hold and in any event the species is so near to *L. repens* that no harm will be done if the two are confused.

These three species have leaflets which are broadly oval, about twice as long as broad, or shorter. Their usefulness, if any, is limited by the difficulty of harvesting seed from the prostrate branches.

L. violacea is an erect species but bushy, fine-stemmed, and sometimes the branches droop so that it seems almost like *L. repens*. The leaflets resemble those of *L. repens* and while there is a technical difference in flower arrangement, this is not always clear. Herbarium specimens of this species are easily confused with *L. repens*, but in the field it will be found that *L. violacea* is always erect, especially in the lower part of the stem, while *L. repens* is always prostrate.

L. nuttallii might be confused with sparsely flowered forms of *L. hirta* as far as flower arrangement is concerned; but the flowers of *L. nuttallii* are violet purple instead of yellowish as in *L. hirta* and the leaflets are long oval—longer and narrower than in *L. hirta*.

When only leaves are present, *L. nutallii* might also be confused with *L. frutescens* and with *L. stuvei* since the shape of the leaflet in these three is similar. The hairs on the stem of *L. nutallii*, however, are spreading, while those on *L. frutescens* are appressed. *L. nutallii* may be distinguished from *L. stuvei* by the less hairy leaflets, those of *L. stuvei* being densely, often silvery hairy.

L. frutescens and *L. virginica* are probably the most hopeful from an economic standpoint. *L. frutescens* is a common species, erect, usually well-branched or even bushy. The leaflets are usually thin, oval or somewhat elongated in shape and variable in size, hairy below but with few or no hairs above. The flowers are borne in dense clusters, each cluster on a short stalk. The differences between this and *L. nutallii* have been mentioned in the foregoing discussion.

L. virginica is possibly the most common species. It has stems erect, slender and often well-branched, usually one to two feet high, densely leafy with long narrow leaflets of nearly the same width throughout and four to eight times as long as wide. Leaflets are usually without hairs above but somewhat hairy below. The flower clusters are crowded in the leaf axils and occur for some distance down the stem.

L. stuvei is fairly common but not as common as *L. virginica* or *L. frutescens*. The stem is erect, about 18 inches to 2 feet high, and not well branched. The leaflets are the same shape as those of *L. frutescens* but are thicker and very hairy on both surfaces, the under surface often silvery hairy.

It is difficult to construct a key that will separate these species when not in flower but it is thought that the following may be helpful:

PLANTS PROSTRATE:
- Stems with spreading hairs..... *L. procumbens.*
- Stems with appressed hairs..... *L. repens.*

PLANTS ERECT:
- Plants low, bushy, leaflets thin... *L. violacea.*
- Plants tall, stiff:
  - Leaflets rounded, almost as broad as long..... *L. hirta.*
  - Leaflets two to three times (rarely more) as long as broad:
    - Stems with appressed hairs or none..... *L. frutescens.*
    - Stems with spreading hairs:
      - Leaflets hairy above and below, often silvery hairy below[3]..... *L. stuvei.*
      - Leaflets not hairy above, moderately hairy below.. *L. nutallii.*
  - Leaflets long and narrow, of nearly the same width throughout:
    - Leaflets four to ten times as long as broad:
      - Few or no hairs above, appressed hairy below... *L. virginica.*
      - Hairy above, densely hairy often silvery below.... *L. angustifolia.*
    - Leaflets narrowed toward both ends:
      - Two to five times as long as wide, densely silvery hairy below..... *L. capitata.*
      - Five to eight times as long as broad, not silvery hairy below, acute at the tip... *L. longifolia.*

This key may serve as a guide, but it must be remembered that the size and shape of the leaflets in all these species is extremely variable. There will be plenty of plants on which no two specialists will agree, but the key should enable field men to place the species with approximate accuracy.

An interesting feature of the American species is their susceptibility to rust. The rust is known as Uromyces lespedezae-procumbentis, and occasionally affects American species severely. The oriental species are immune from this form of rust, though a rust described under the same name attacks these species in the Orient. This appears to be a case of physiological races in rusts.

[3] *L. simulata* can be distinguished from *stuvei* only by the color of the flower and by the long calyx lobes.

Hubam Clover

Apparently, Hubam clover (*Melilotus alba annua*) is one legume that can be grown successfully in competition with cotton root rot. This winter annual makes its growth during a season when the organism causing the cotton root rot is dormant.

The acreage of Hubam clover is increasing rapidly in the Black Belt of Texas as well as in other cotton root rot areas. Farmers are realizing some exceptional returns per acre, as the seed is much in demand and the price per pound is high.

This development appears to indicate that diversification in one-cash-crop regions is the answer to many problems. When proper rotations are worked out, accompanied by a field arrangement that approaches efficient land use, the control of soil erosion becomes much less of a problem.—*C. R. Enlow.*

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

PLANT ECOLOGY. By John E. Weaver and Frederic E. Clements. New York and London. 1938.

This revision will be welcomed by all those who are aware of the importance of a knowledge of the relationships between plants or groups of plants and their environment. The fact that there has already appeared, above the signatures of various reviewers, considerable discussion, criticism and praise concerning changes, additions and omissions in the revised text is in itself proof of its value and of the increasing interest in plant ecological studies. Certainly there is a great quantity of valuable material between pages 1 and 538, and no one is likely to express any objections to the enlarged bibliography—originally there were 601 entries; now there are 1,035. This, too, is evidence of the rapidly growing interest in the subject.

The chapter entitled "Coaction and conservation" will arrest the attention of soil conservationists in particular, as much new and useful information is included and the organization of subjects is interesting and thought-provoking. These few lines from the authors' introduction to the chapter will perhaps give the idea behind the discussion of coaction and conservation under one heading: ". . . destruction [of plants and animals] often involves reaction as well as coaction, and it is likewise true that conservation must combine both of these processes in the proper degree. In nature especially, the numerous coactions of the plants and animals of a community form an intricate network of processes, most of them still awaiting detailed study. In consequence it proves desirable to select for treatment a few outstanding examples as representative of the various types. Such as pollen, seed, and other food coactions on the one hand, and on the other the disturbances caused by man directly or indirectly, as seen in clearing, lumbering, overgrazing, cultivation, and construction, or in changed populations of animals, such as game, predators, rodents, fish, or insects."

Following this we are given the details of some of the coactions of plants and animals (including humans): Pollination, chiefly by insects; seed production and distribution as disturbed by birds, rodents, and man; coactions of the plant body as affected by the food habits of grazing animals, rodents, and man. It is thus that the authors tie up ecological studies and conservation, nor do they hesitate in proceeding immediately into that section of their book which treats directly with conservation of soil and water. Cultivated fields, pasture and range, forest and chaparral, windbreak and shelterbelt, highways and erosion control, control of floods, wildlife conservation—these are the headings used in a discussion, from the ecological standpoint, of the "basic principle of protection by [plant] cover" and the need for an understanding of helpful coactions and harmful ones in the matter of soil and water conservation methods.

More than half the book is unchanged in the revision, except for the substitution of a different word here and there, as xeric for xeroid and disclimax for subclimax. The chapter on "Methods of studying vegetation" is greatly changed, however, and enlarged to include material on basal area, clip, frequency-abundancy and pantography-chart quadrats, isolation transects, the relict method, pollen analysis, etc. The discussion of "Soil in relation to plant development" is in certain parts new and contains much recent and useful information concerning soil structure, soils development, water-content and factors modifying it, and soil air. Special treatment is given saline soils and acid soils. The chapter on "Soils in relation to plant development" introduces "Reaction and stabilization" with considerable new material in relation to erosion control. The chapter on "Migration, ecesis, and aggregation" has been rearranged for a more logical presentation, and now constitutes an excellent study of the causes that produce the successive waves of plant populations.

The book throughout places the emphasis on the grassland, and conservationists will find much valuable material for adaptation in range management studies. The chapter dealing with the "Relation of underground plant parts to environment" gives thorough treatment of the subject of root development under varying conditions. Root variations and growth habits as affected by environmental conditions are carefully described and illustrated. Special emphasis is given certain environmental conditions—high water content, low water content, soils rich in plant nutrients, saline and acid soils, soils of loose or compact structures, soils of varying temperatures and aeration. The relation of roots to cultural practices is stressed, and detailed treatment is given the subject of root habits within the community, underground stems and root offshoots, and soil organisms in relation to disease.

That section of the book which treats of light as one of the most important factors determining the growth of plants and the development of vegetation has been rewritten to include a great deal of new material which is particularly adaptable to the problem of extending the northern or southern range of crop plants.

There is no doubt that this revised edition of Plant Ecology will be widely used, as no other text brings together so much material from the diverse fields of the study of plant growth and distribution. Ecologists will point out minor errors and inconsistencies of organization; but the soil conservationist with profound interest in plant cover as protection from erosion will greatly appreciate the volume as a concise and carefully organized presentation of the material. As a matter of fact, the conservationist will not read very far before he will realize that in compiling the revision the authors' objective was to build up a text on plant ecology that would place strong emphasis upon the importance of plant cover in stabilizing soil against erosion by wind and water.

THE PROBLEM OF SOIL EROSION IN THE BRITISH EMPIRE WITH SPECIAL REFERENCE TO INDIA. By R. Maclagan Gorrie. London. 1938.

This excellent paper is to be found in the Journal of the Royal Society of Arts, July 29, 1938. Dr. Gorrie, of the Indian Forest Service, has been seconded for a special study of the old and disastrous erosion in India and here he presents a review of conditions and policies in the light of recently acquired experiences. Into the 24 pages of his discussion he has packed a great deal of information regarding the widely varying problems of Great Britain's far-flung colonial areas. Special characteristics of the Punjab are cited and described as applicable to almost all tropic and semi-tropic countries included in the British Empire: erratic rainfall with torrential storms in mountainous catchments; heavily eroded foothills and silted plains and valleys; heavy concentration of population on areas which should be managed for water conservation; ancient agricultural methods persisting in over-populated areas; increase in animal production as the result of hereditary or religious inhibitions about reducing animal numbers. Aside from these general characteristics, many local problems are pointed out as exceedingly important. Dr. Gorrie stresses the need for ". . . a flexible conservation technique for the reasonable use and development of all land and water resources as they relate to each other, holding as our common purpose the welfare of the people whom we help to serve or govern."

At the beginning of the paper we find an interesting study of

the effect of plant cover upon soil profiles—forest soil with its layer of humus, grassland soil, ploughland soil with an impervious plough sole, grazing ground with stony and silt-sealed surface. Following this are some fresh statistics on erosion losses in India and a summation of needed surveys to constitute a first step in attacking the erosion problem in severely eroded areas in that country. "Unfortunately," states Dr. Gorrie, "the best individual instance of practical control measures so far produced in the Punjab is of only local importance. This is the Katardhar, the outer slope of the heavily eroded Hoshiarpur Siwalik ridge, whence a series of sand torrents have spread a useless mantle of sand so deep over the surrounding plains that no surface run-off ever reaches the nearest river but is engulfed in the sand. Part of these slopes were brought under legal closure by a local act some 30 years ago, and have recently been further improved by a successful campaign to encourage the voluntary closure of grazed areas and the replacement of uncontrolled grazing by grass cutting. As there is a ready market on the adjoining plains for cut grass the response has been good, and some 60,000 acres of closures have been effected in 3 years . . . The next area now being taken up on the inner slopes of the Siwalik and the adjoining Himalayan foothills is of wider national importance, as the stream-flow from it contributes directly to the Sutlej Canal Colonies where winter water shortage is an acute problem."

In outlining the plans for coordination of erosion control measures in India, Dr. Gorrie has given us an extremely interesting résumé of the work of the recently organized Rural Construction whose staff members are now preparing improvement schemes, and of the provincial committee of the United Provinces' 5-year plan. The committee is to "examine research projects and initiate fodder and grazing experiments; examine the possibilities of increasing firewood and so do away with the use of cowdung as fuel; develop fodder production from the eroding ravine lands of the Gangetic plain; and extend the system of growing fodder trees under *taungya* cultivation already so successful in the poorer forest types in Saharanpur and Dehra Dun. In this province the fodder requirements amount to 30,000 tons a day; the weight of cowdung burnt yearly is far in excess of the total weight of timber and firewood extracted from Government forests; and there are some 13,000 square miles of uncultivated waste, much of which with proper management could produce more fodder and fuel than it does now . . ." It appears that the problem of soil conservation and land utilization in India is similar in many respects to that of China.

The closing sections of Dr. Gorrie's paper give somewhat brief and generalized descriptions of forest conservation, streambank protection, grassland conservation and improvement, control of farm lands, and legal control of important catchment areas, as planned and initiated in the British Empire as a whole. Those who read this discussion will be deeply impressed by the magnitude of the task confronting the British in their efforts to set up a new standard in land management for the widely separated regions within the Empire.

ECONOMIC UNITS FOR THE DUST BOWL

(Continued from p. 81)

Farm Security Administration loans, are ready and eager to change their system of operations. A report of June 30, 1938, shows that 58 of these reorganized units had been completed and approved by the Farm Security Administration and the Soil Conservation Service.

An analysis of these 58 reorganized units gives the following data: The total acreage before reorganization was 29,180 acres or an average of 503 acres per unit. The total acreage after reorganization was 133,816 acres or an average of 2,307 acres per unit. The total acreage was divided as follows: Range land 99,478 acres; restoration land 14,602 acres; cropland 16,000 acres, and other lands 3,736 acres. The livestock inventory, including range cattle, dairy cattle, and horses was 16.6 animals per unit before reorganization and 36.2 head after reorganization and purchase. The livestock goal, taking into consideration loan repayments and range and restoration land improvements, is an average of 71.3 animals per unit. Range and restoration land in these units including 114,080 acres are to be grazed and managed as outlined in the plan of conservation operations; 46,977 acres of range land are to be contour furrowed; 54 stock dams are to be built, and 35 springs are to be developed by the unit operators.

Cropland amounting to 14,173 acres is to be contour farmed. Where erosion nonresistant crops are grown they will be planted in a strip-crop pattern with erosion resistant crops.

In addition to the 58 reorganized units which were completed on July 1, 1938 the Service technicians had 64 other units in various stages of reorganization. These 64 units represent an additional 164,000 acres of land which is to be included in the program. Additional requests for this type of work are received daily and it is felt that this coordinated program will render a great service in the Dust Bowl and adjoining areas.

Italian Ryegrass

In the January 1938 issue of this magazine it was pointed out that domestic ryegrass offers excellent possibilities for winter pasture and probably seed production in Oklahoma. No doubt this is also true of Arkansas and northern Texas.

There are many improved strains of Italian ryegrass which are far superior in production to domestic ryegrass. Many of these strains have been under test by the Bureau of Plant Industry for several years and I am of the opinion that some of the strains should be introduced into a locality where a winter pasture that will reseed is needed and where seed production of this plant could be studied.

In this connection, the Bureau of Plant Industry has also tested many improved strains of perennial ryegrass obtained throughout the world. Several of these show promise. Before perennial ryegrass seed is purchased, however, inquiry should be made to the Washington office.—*C. R. Enlow.*

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